Space Weather Technical Forecast

Issued on Friday, 21 July 2023 at 01:25 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of R1/R2 throughout. Chance of G1/G2 today.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low, with the largest flare a C9.7 peaking at 20/1949UTC. For most of the period the solar activity has been stable at low C1 levels. There are currently seven sunspot regions on the solar disc. There has been little or no change with any of the regions during the period. AR3373 remains the largest and most complex region, with at least one small Mt Wilson delta spot, and has produced the largest flare of the past 24 hours. AR3372 and AR3379 persist as elongated groups, with moderate magnetic complexity, but have been stable. The remaining regions are smaller, weak and magnetically simple. A new region, at a high southern latitude, was previously visible but has recently faded.
No Earth-directed CMEs were observed in the available imagery.

Solar Wind / Geomagnetic Activity: Solar wind parameters, as measured by ACE and DSCOVR at L1, showed a stable slow wind regime until the afternoon. Then the first expected CME, from 18 July, arrived at L1 at 20/1610Z, with the speed jumping from 375 to 450km/s, then peaking at 487 km/s at 20/1750 UTC. The solar wind speed is currently around 400 km/s. There still remains a second CME to arrive in the forecast.

The IMF was steady at or below 5nT until the CME arrived and then reached 12 nT at 20/1627 UTC, ending the day at moderate levels around 9 nT. The Bz was initially weakly positive, then changed to fluctuating after the CME arrived, reaching -10 nT at 20/1635 UTC, but ended the period weakly fluctuating. The phi angle was predominantly negative (towards the Sun). The density was mostly at average levels, but temporarily increases to above average levels after the CME arrived, peaking at 16 ppcc. The net effect of the above solar wind measures was for Quiet (Kp 0-2) conditions, which temporary increased to Active (Kp 4) levels between 20/1500-2100 UTC.

Energetic Particles / Solar Radiation: The high energy (greater than 2MeV) electron flux remained largely at Moderate levels, but increased above the High threshold (1000 pfu) after the CME arrived, between 20/1635-1855 UTC peaking at 1856pfu at 20/1730UTC. The 24-hour integrated fluence remained well below the Active (1e8 integrated pfu) threshold, with a generally steady trend. A fluence of 6.0e7 pfu was recorded at 20/0001UTC.
The high energy proton flux (greater than 10MeV), as observed by GOES16, fell through the 10pfu S1 threshold, having started the period at 12 pfu to end the day around 2 pfu, therefore still slightly elevated above background levels.

Four-Day Space Weather Forecast Summary

Solar Activity: Activity carries a chance of returning to Moderate over the following days, with a Chance of isolated M-class flares and a Slight Chance of an X-class flare. However, activity may increase as later in the period new regions are likely to rotate onto the visible disc.

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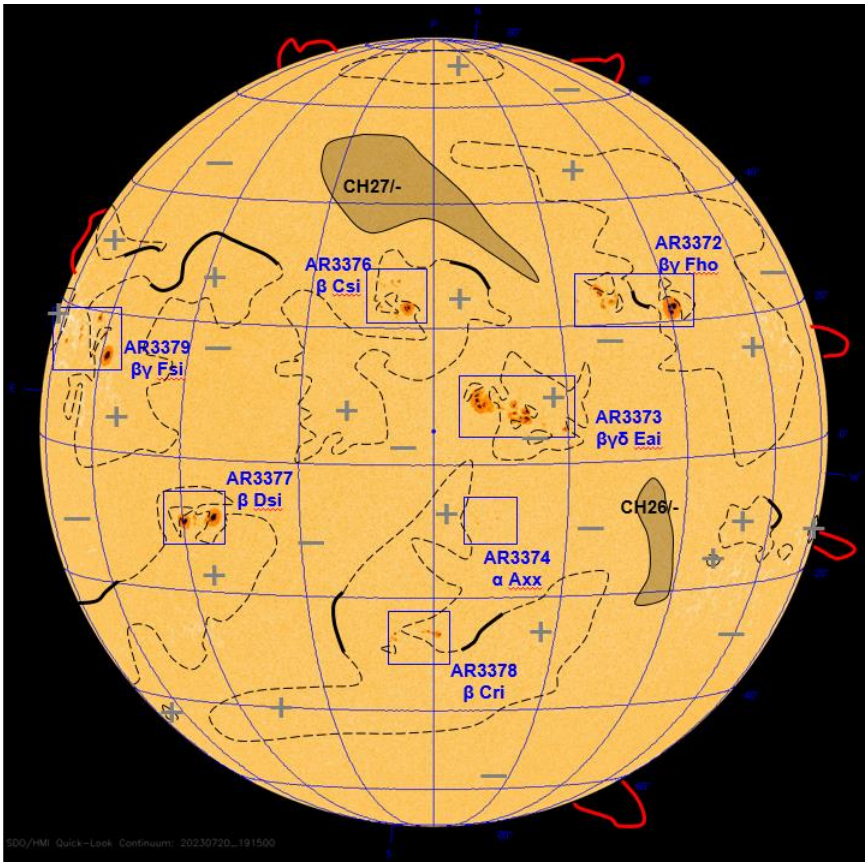
Met Office Space Weather Technical Forecast

Solar Wind / Geomagnetic Activity: One Earth directed CME may arrive today, but confidence is low regarding this, leading to a chance of G1/G2 intervals. There are no further CME's expected during the period. Coronal hole influence is possible from CH26 in the southern hemisphere, with a weak HSS potentially arriving today or tomorrow, and then persisting for up to 2 days with speeds around 450-500 km/s. Then by the end of the forecast period declining HSS influence is expected, with the solar wind returning to background levels.
Geomagnetic activity is expected to be Quiet to Unsettled (Kp 2-3) today and tomorrow, with occasional Active(Kp 4) intervals and a chance of G1/G2 minor to moderate geomagnetic storm (Kp 5) intervals today.

Energetic Particles / Solar Radiation: The high energy electron flux (greater than 2MeV) is now at background levels, but is likely to increase to Moderate to High levels from tomorrow. Therefore there is a gradually increasing Chance of the fluence reaching Active 24-hour integrated levels.
The high energy (greater than 10MeV) proton flux is expected to continue to decline, reaching background levels. Later in the period there is a slight increase in the possibly of S1 as AR3373 rotates further across the western hemisphere.

Figure 1. Solar Analysis Valid 20/1915 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME was observed leaving the Sun from the northeast limb around the same time as the M2.1 flare that occurred around 18/2000UTC. While the bulk of the ejecta is believed to head east of the Sun-Earth line, it may give a glancing blow today (Friday 21 July). Satellite imagery was very scant during the eruption, giving low confidence in this analysis. Coronal hole influence is possible from CH26 in the southern hemisphere, with a weak HSS potentially arriving today or tomorrow, and then persisting for up to 2 days with speeds around 450-500 km/s. Then by the end of the forecast period declining HSS influence is expected, with the solar wind returning to background levels.

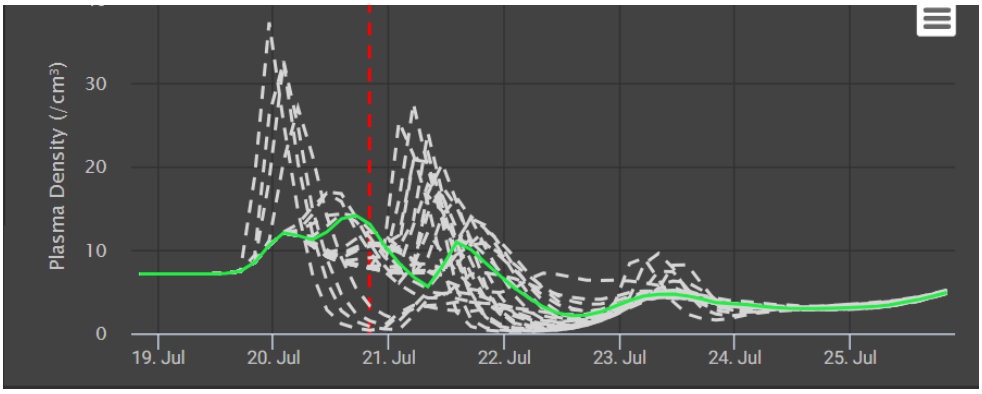
Geomagnetic activity is expected to be Quiet to Unsettled (Kp 2-3) today and tomorrow, with occasional Active(Kp 4) intervals and a chance of G1/G2 minor to moderate geomagnetic storm (Kp 5) intervals today.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	10	1	1
Strong	G3	No	5	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
18/2300	Asymmetric	M2.1 from AR3376	NE quadrant	1200km/s	21/0900UTC +/-6 hours	Bulk passing W of Earth.

Figure 2: Met Office Enlil ensembles



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Radio Blackouts - X-Ray Flares:

There are currently seven sunspot regions on the solar disc. There has been little or no change with any of the regions during the period. AR3373 remains the largest and most complex region, with at least one small Mt Wilson delta spot, perhaps two, and has produced the largest flare of the past 24 hours. AR3372 and AR3379 persist as elongated groups, with moderate magnetic complexity with beta-gamma configurations, but have been stable. However, AR3379 poses the energy levels required for a significant flare.
Activity now carries a Chance of returning to Moderate, with AR3373 the most likely to supply significant flare, although new regions will rotate onto the disc through the period and potentially increase the chance of flares.

X Ray Flares / Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 M Class**	No	45	45	45	45
Very Active	**R3 to R5 X Class**	No	5	5	5	5

Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux previously crossed the S1 threshold on a downward trajectory, having earlier reached a peak of S2 and 620pfu at 18/0620UTC. The chances of further such occurrences have now diminished, as the region responsible continues to rotate further across the far side. However, AR3373 and AR3376 will transit across the western hemisphere over the coming days, and therefore the probabilities increase slightly towards the end of the period.

Radiation Storms / Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	Yes	10	10	10	15
Very Active	**≥ S3 ***	No	0	0	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

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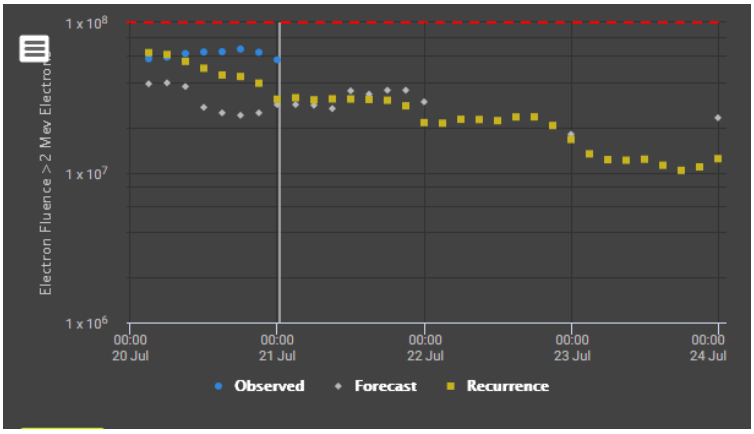
The high energy electron flux (greater than 2MeV) is now at background levels, but is likely to increase to Moderate to High levels from tomorrow, partly under the influence of a potential weak HSS from CH26 in the southern hemisphere. There is a gradually increasing Chance of the fluence reaching Active 24-hour integrated levels.
The REFM is not considered reasonable guidance, keeping the fluence below the Active threshold, but a gradually increasing trend is preferred.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	5	20	30	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 3: Met Office REFM model



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